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ABSTRACT

Based on educational, social, political, and other considerations, an instructional satellite system, AVSIN (Ausio-Visual Satellite Instruction), is hypothesized which represents one possible organizational and administrative arrangement for delivering large amounts of quality software to schools and learning centers. The AVSIN system is conceived of as a cooperative public-private sector effort in which a non-profit instructional satellite corporation controls the satellite, but in which software is made available to schools on a competitive basis. Using AVSIN as a point of departure, other alternative organizational schemes and the possible future role of existing organizations involved in public and instructional television are discussed. An appendix contains an assessment of long-range social and political implications which a large-scale instructional satellite system may have for United States education. Particular attention is given to requirements for providing equality of educational opportunity. (Author/JY)

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PROGRAM ON APPLICATION OF COMMUNICATIONS SATELLITES
TO EDUCATIONAL DEVELOPMENT

WASHINGTON UNIVERSITY

Internal Memorandum No. 71-2

July 16, 1971

AN INSTRUCTIONAL SATELLITE SYSTEM FOR THE UNITED STATES:

PRELIMINARY CONSIDERATIONS

James R. DuMolin
Robert P. Morgan

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SUMMARY

Washington University has undertaken a NASA sponsored program on Application of Communication Satellites to Educational Development. This memorandum, based upon work initiated in early 1970, explores in a preliminary way certain aspects of the potential use of communications satellites for large-scale distribution of instructional media, primarily television, in the United States.

Based upon educational, social, political and other considerations, an instructional satellite system, AVSIN, is hypothesized which represents one possible organizational and administrative arrangement for delivering large amounts of quality software to schools and learning centers. The AVSIN system is conceived of as a cooperative public-private sector effort in which a non-profit instructional satellite corporation controls the satellite but in which software is made available to schools on a competitive basis. Using AVSIN as a point of departure, other alternative organizational schemes and the possible future role of existing organizations involved in public and instructional television are discussed. A more detailed study of technical and economic feasibility as well as further exploration of alternatives to such a system remain to be performed before firm conclusions concerning the AVSIN system can be reached.

An Appendix to this memorandum contains an assessment of long-range social and political implications which a large-scale instructional satellite system may have for United States education. Particular attention is given to requirements for providing equality of educational opportunity.

AN INSTRUCTIONAL SATELLITE SYSTEM FOR THE UNITED STATES:

PRELIMINARY CONSIDERATIONS

I. INTRODUCTION AND BACKGROUND; DESIGN CONSIDERATIONS

Washington University (St. Louis) is undertaking an interdisciplinary research and education program which is examining the potential and problems associated with the use of communications satellites for educational development, primarily within the United States. The principal objectives of this NASA-supported program include the definition of systems and strategies for helping to meet U. S. educational needs utilizing communications satellites, and the assessment of the impact of such systems upon the U. S. education.

The study reported herein represents one of the first investigations performed in the Washington University Satellite-Education Program, having been initiated in early 1970.* In contrast to previous work performed elsewhere which has emphasized the technical systems performance and capability of television broadcast satellites[1,2,3], the primary focus in this study has been on social, political, educational and organizational considerations involved in the definition of a large-scale system for delivering instructional media and information, primarily television, via satellite. Technical and economic feasibility of such a system have not been addressed to any great extent and remain to be evaluated.

Few studies have been performed which are closely related to the current work. In 1968, an interdisciplinary faculty team developed a preliminary design for EDUSAT, an Educational Television Satellite System for the United States in the Mid-1970's.[4] A preliminary technical system design was performed and consideration was given to the organization, management and funding of an educational satellite corporation which encompassed public, special and instructional television. The Board of Directors of the non-profit EDUSAT corporation was to be made up of major interests involved in educational media. Relatively little attention was paid to software quality, availability and production requirements as well as to other factors which might promote or impede the acceptance of an educational satellite system by teachers and school administrators. These latter concerns have been addressed in this memorandum.

More recently, Sheppard has proposed an instructional satellite system for the U. S. involving seven synchronous satellites.[5] In his work, the country is divided into fifteen regions each containing one to six

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*The authors are grateful to their colleagues in the satellite-education program for many helpful discussions and, in particular, to Mr. Jai P. Singh for detailed comments on the manuscript. The responsibility for the work remains that of the authors. We also wish to thank Mrs. Emily S. Pearce and Miss Barbara Morose for their skillful typing of this memorandum.

states with roughly equal numbers of pupils. Each region would have the capability for a minimum of one TV channel plus data capacity to allow one terminal for computer-assisted instruction (CAI) for every 25 students. In contrast to the EDUSAT study, Sheppard broadens the range of instructional media and information which might be delivered by a satellite to include other than television programs although he by no means exhausts all possibilities. His study focuses on hardware and media requirements and costs. Some consideration is also given to social and political factors which arise from potential conflicts between local and state educational control and the assumed equipopulation regions in Sheppard's system.

In addition to the studies described above, there have been a number of proposals made in recent years by various organizations for using communications satellites in the United States both for commercial and non-commercial purposes which bear some relation to the work reported in this memorandum. In 1966, in response to a Notice of Inquiry by the Federal Communications Commission concerning domestic communications satellite facilities, the Ford Foundation proposed a Broadcasters' Non-Profit Satellite Service for distributing both commercial and non-commercial radio and television programming.[6] The Service would be authorized to collect revenues from commercial broadcasters and with these revenues, subsidize both free access and production of programming for non-commercial broadcasters. However, the production of instructional programming, that is programming designed for use in the schools, would not be included in this arrangement.

More recently, the FCC solicited proposals to establish and operate domestic satellite facilities, requiring that applicants state terms and conditions for providing services to non-commercial broadcasters and educational institutions. Eight such proposals were received from various commercial organizations. A summary of their public service responses and some remarks concerning the extent to which such proposals meet public broadcasting requirements have been presented elsewhere.[7] National public broadcasting organizations have emerged as a result of the Public Broadcasting Act of 1967 to define domestic satellite requirements for public radio and television. However, because of the local nature of U. S. education, the definition of requirements and opportunities for instructional media and telecommunications in the schools is a more difficult problem. Media and telecommunications for instruction are a major concern of the U. S. Office of Education which is initiating studies of U. S. educational telecommunications requirements and is a major focus of the overall Washington University study insofar as it forms an important part of the basis for educational satellite systems synthesis. The primary emphasis in this memorandum is on instructional as opposed to public television.

In this work, we have defined, primarily in qualitative terms, the organization and operation of one possible scheme for nationwide

distribution of instructional programming via communications satellite.* The particular system, AVSIN**, which is presented in detail in Section II, was arrived at after developing the set of Design Considerations which are summarized in Table 1. These Design Considerations which were formulated after study of previous experiences with instructional television[8] and after examination of the Midwest Program of Airborne Television Instruction (MPATI)[9], will be discussed in Sections II and III of this memorandum.

Using AVSIN as a point of reference, other alternative organizational schemes and the possible future role of existing organizations involved in public and instructional television are discussed. A variety of ground reception arrangements for distribution of AVSIN signals are evaluated in terms of factors such as control and acceptance by teachers, responsiveness to individual school needs and scheduling flexibility. In Section III, a preliminary analysis is provided of instructional TV software production requirements and of financing of the AVSIN system. An Appendix to this memorandum contains an assessment of long-range social and political implications which a large-scale instructional satellite system may have for United States education. Particular attention is given to requirements for providing equality of educational opportunity.

It is believed that this study provides information and insights which will be helpful to the systems designer. Future quantitative studies of educational needs and telecommunications requirements as well as experiments*** are needed to provide a firm base for examining the feasibility of utilizing communications satellites in either regional or national distribution systems. Alternative methods of organizing and administering instructional satellite systems remain to be proposed and examined. The AVSIN system appears to have the potential for spurring the development of large amounts of quality software, which we believe to be a major requirement for a large-scale instructional telecommunications system. However, essential market and cost-benefit studies are yet to be performed. These and other conclusions and recommendations are included throughout this memorandum.

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* The study was carried out in parallel to work by Ohlman[10] which contains a qualitative proposal for a multi-media, multi-purpose educational satellite service. Both the Ohlman study and this study benefitted from frequent discussions among the authors. These studies precede a more comprehensive effort now underway at Washington University to examine opportunities, develop quantitative requirements and synthesize national and regional distribution systems for delivering a wide variety of educational telecommunications services via satellite.[11]

** AVSIN is derived from Audio-Visual Satellite Instruction. The system is conceived of as utilizing a variety of communications media, including television.

***An example of one such experiment is the recently announced agreement between NASA, HEW and CPB to provide experimental transmissions using the 2.5 GHz band and the ATS-F satellite.[12]

TABLE 1

AN INSTRUCTIONAL SATELLITE SYSTEM FOR THE U.S.

DESIGN CONSIDERATIONS

A. EDUCATIONAL

1. High-Quality Instructional Programming Material in Sufficient Quantity
2. Five to Seven Day Access to Continuous Curricula Programming
3. 24 Hour Demand Access to Supplementary and Enrichment Programming
4. Ability of Teacher to Preview, Edit, Dub, and Schedule

B. POLITICAL

1. "Local Control" and Selection of Programming
2. Federal Subsidy without Federal Control of Program Content

C. SOCIAL

1. Equitable Distribution
2. Large, Flexible Source of Programming to Meet Educational Needs of Diverse Groups

D. ADMINISTRATIONAL

1. Effective Billing
2. Royalty and Copyright Protection
3. Good Instrallation, Maintenance and Upkeep

E. ECONOMIC

1. Provide Financial Basis for Production of Quality Software by Allowing for a Large Number of Users to Lower Per-Pupil Costs.
2. Federal Funding for Non-Software Aspects
3. Development of System on Self-Sustaining Basis Through Users Fees, etc.

II. DESCRIPTION OF THE AVSIN SYSTEM

A. Introduction

This section contains a description of the organization and operation of the AVSIN system. Certain aspects have been described in detail to provide a basis for better understanding of the organizational requirements for systems operation. In general, the approach in this Section has been to focus primarily on one set of possibilities in terms of over-all systems organization. Other alternatives should and will be considered, both in this report and in later stages of the Washington University study.

There are a number of satellite-to-ground-to-school distribution possibilities, all of which are to some extent compatible with the AVSIN design, but which differ both in their physical requirements and in their educational utilization characteristics. These distribution arrangements include:

Alternative No. 1. Direct reception of real-time satellite signals for instantaneous viewing in schools and learning centers.

Alternative No. 2. Direct reception of satellite signals in schools and learning centers with capability for recording and play-back at the teacher's request.

Alternative No. 3. Reception of satellite signals at a central reception center with capability of recording and redistributing programs to schools or learning centers via cable, ITFS*, or local broadcasting equipment. Schools or learning centers would be equipped with recording equipment (but not reception terminals) and could replay when desired.

Alternative No. 4. Similar to Alternative No. 3 but with no recording equipment in the schools or learning centers so that programs are relayed directly from a central reception center to classroom TV sets.

Although the AVSIN system is to some extent compatible with all of these alternatives, the descriptive material which follows is keyed to Alternative No. 2. In Section II. J., the various alternatives are analyzed qualitatively in terms of their educational utilization characteristics.

The core of the hypothetical AVSIN system is a multi-media instructional satellite. (See Figure 1). Technically, it would have the capability of broadcasting a small number of full-motion television signals or a large number of audio or still-picture channels to all fifty states and U. S. Territories. The audio channels would be used for instructional radio, high fidelity music, or as accompanying sound for the visual channels. Video channels would have the capacity to broadcast selected still pictures such as slides, film strips, microfilm data and specially edited presentations of normal television and film programs. Video channels could utilize

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*ITFS = Instructional Television Fixed Service.

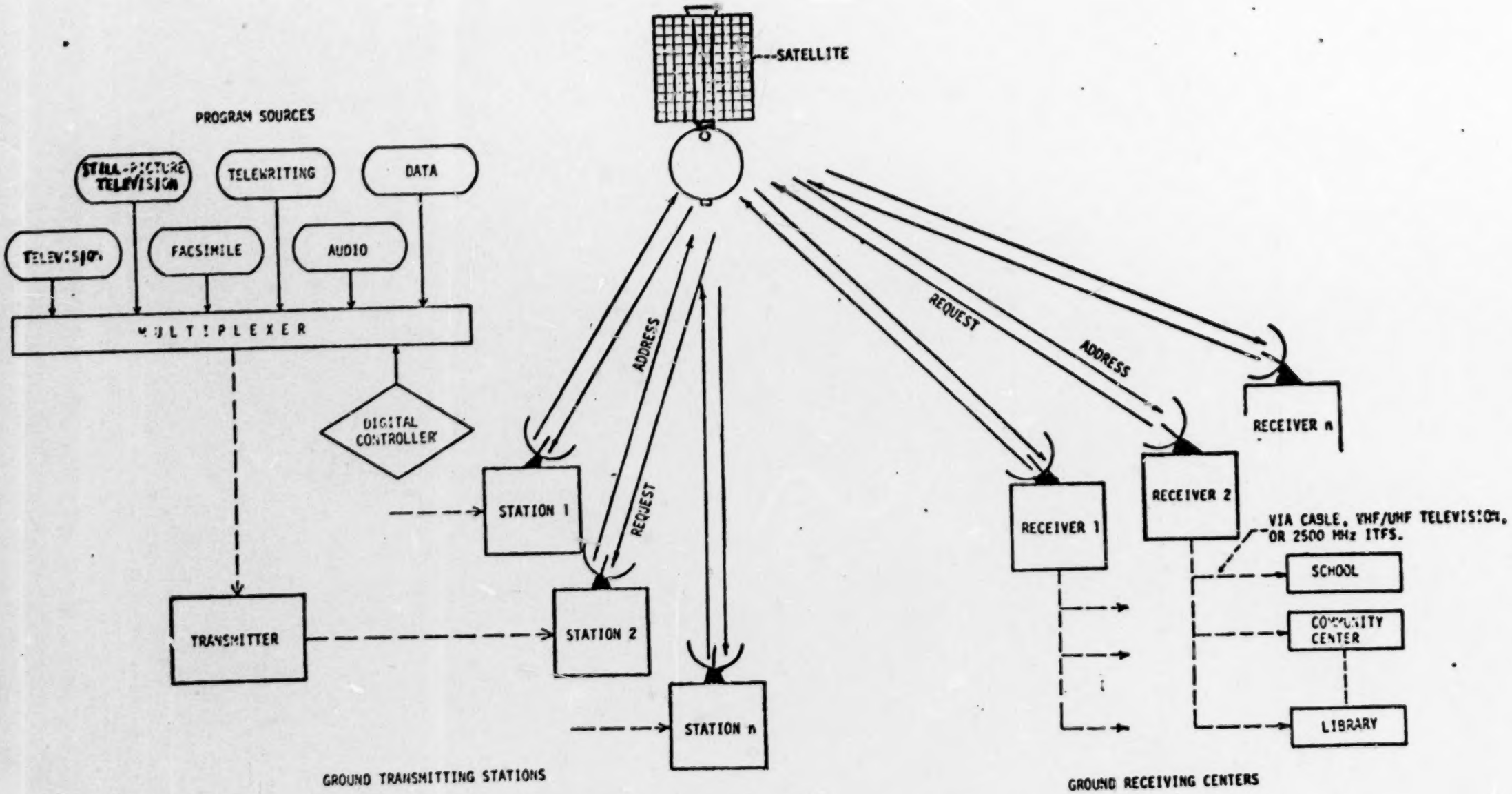

Figure 1: Multimedia, Multipurpose Educational Satellite Service*

*(From Reference 11).

slow-scan or time multiplexed broadcasting and recording techniques with storage and special playback facilities linked to unadapted normal television and earphone sets. The system could also be used to transmit data for computer-aided instruction, computer resource sharing, etc.

Figure 1 illustrates how various signals of this multi-media system are multiplexed and transmitted. Figure 2, developed by Ohlman[10], depicts the wide range of equipment and services which could be conceived of in a full-complement ground reception center. For still-picture video, various video signals can be time-division multiplexed and transmitted in a form that is easily converted to a standard video signal, in accordance with a scheme proposed by Sharma[13].

Locally generated audio-visual media can be integrated into the AVSIN system. Local films can be linked by a film chain into a program selector and distributed simultaneously by television to the desired classrooms. Language tapes and music lessons would follow the same route as audio signals recorded from the satellite through a program selector for distribution to listening centers equipped with radios and headsets.

The AVSIN system has the added advantage of being able to handle facsimile transmission over its A/V* channels. In this way, supplementary printed matter (teachers guides, discussion questions, tests, etc.) can be distributed to the school along with the A/V instructional material. The facsimile unit can produce a single copy which can be reproduced on school equipment. The unit can be linked to a master scanner which will automatically cut a master ditto stencil.

A receiving center of the size and scope depicted in Figure 2 would present the teacher with a variety of media to work with in a flexible mode of operation. However, the costs for placing this much equipment in individual schools would clearly be prohibitive. On the other hand, one can conceive of centrally located ground reception centers serving a large number of schools with ground distribution being accomplished by cable or ITFS. Furthermore, it may be that some subset of the equipment shown in Figure 2, capable of providing limited service, might be economically feasible for schools in remote areas. In this section we have briefly presented the possibilities. The necessary economic analysis remains to be performed.

B. Organization of the AVSIN System

In the AVSIN system, it is proposed that there be two independent spheres of activity and control, 1) the administrative segment and 2) the program-production segment. (See Figure 3.) Administration is to be the responsibility of a non-profit instructional satellite corporation. This Corporation would have control over the following system segments:

a) The central ground-based broadcasting station or stations

b) The satellite or the necessary number of satellite channels

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*audio and/or video

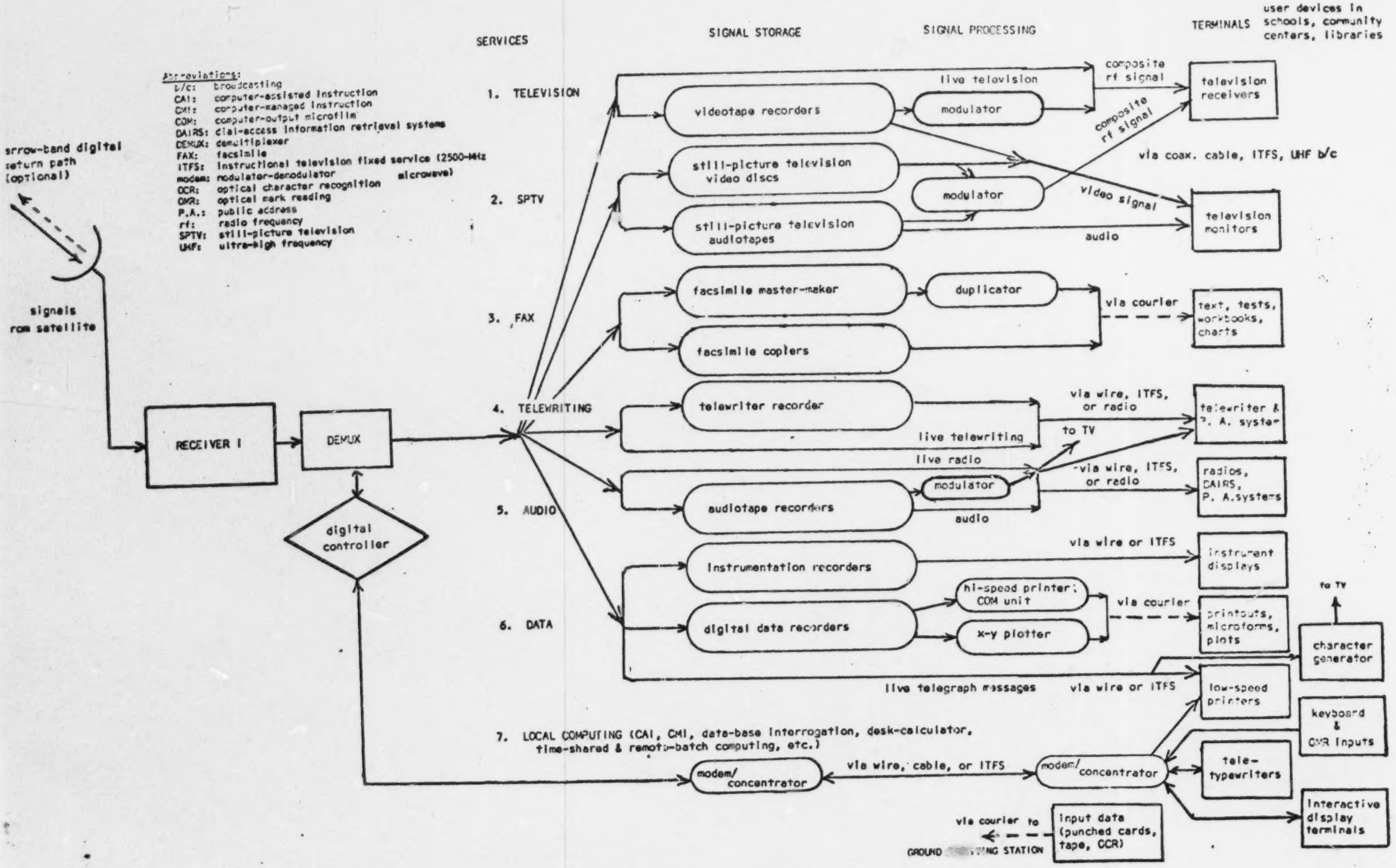


Figure 2: Full-Complement Ground Receiving Center *

*(From Reference 10)

c) The receiving terminals in schools, learning centers, ground reception centers

d) The computerized dial-access ordering and accounting system.

In effect, the non-profit corporation would function like a common carrier. Control of the ground equipment may be necessary to prevent unaffiliated schools from picking up programs as was the case with MPATI[9], although the latter was a case of broadcasting in the UHF band with easy access and no legal restrictions against picking up signals without paying. More detailed discussion of the issue of ownership of ground equipment is presented in Section II. E. The non-profit corporation structure was chosen to ensure that the organization would provide service to outlying and rural schools where operation might not prove sufficiently attractive to a profit-making corporation. It is in these schools where satellite-distributed instruction may prove to be of great advantage. On the other hand, a profit-making corporation might be made to provide such service to comply with public interest requirements of appropriate regulatory agencies.

The program material to be broadcast over the system would be provided for on a competitive, open-market basis. That is, any producer of educational media which is capable of being broadcast would be given the opportunity to market his product over the system. This separation of the administrative and program-production segments is similar in concept to the separation of programming and transmission operations for broadcast satellites proposed by Hult.[14]

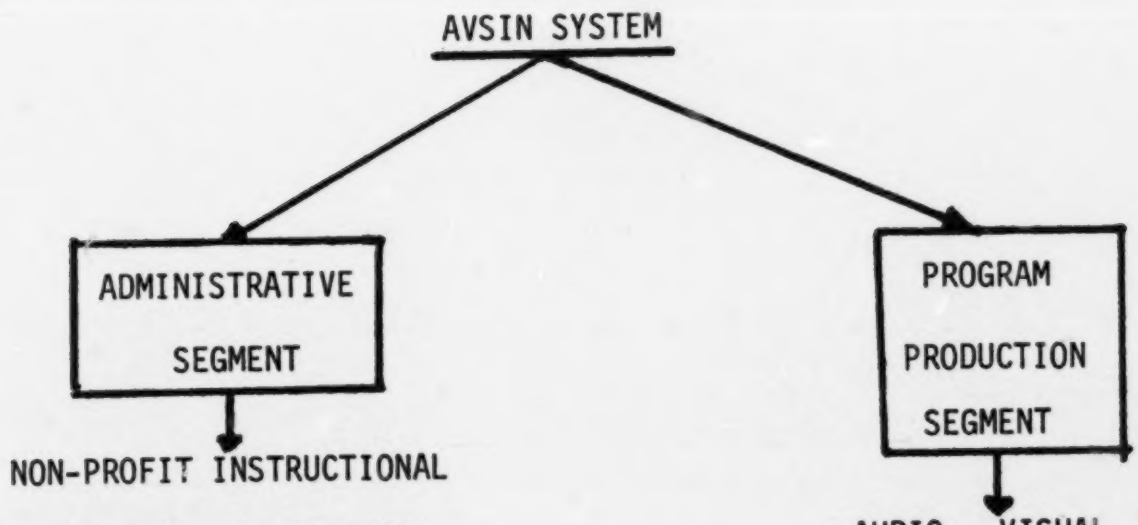
The proposal that AVSIN be established as a non-profit instructional satellite corporation is in keeping with the precedent set by The Public Broadcasting Act of 1967, which established the Corporation for Public Broadcasting (CPB)[15] under the Nonprofit Corporation Act of the District of Columbia. In lieu of a nonprofit management structure, a profit-making organization might be substituted. In this way the original investment cost for the initiation of the project would be borne by a commercial entity instead of depending on financing from the federal government. In some ways this might prove to be the true test of the economic feasibility of satellite education. In addition, with profit as a major concern of the organization, a more efficient and responsive attitude might follow.

However, with profit as a major factor, it is unlikely that such an organization would want to provide its services to outlying and rural schools in states where the cost of establishing maintenance and installation service for receiving equipment would probably prove to be uneconomical for the number of schools involved. It is to these rural schools where it is difficult to attract qualified teachers that satellite-distributed instruction might be of the greatest advantage. On the other hand, regulation in the public interest might require a profit-making corporation to provide such service.

Recent domestic satellite filings indicate that the prospect of a profit-making corporation assuming ownership of a large-scale instructional distribution system of the kind envisioned in the AVSIN system is still far in the future. Although at this stage we can not yet specify programming

FIGURE 3

ORGANIZATION OF AVSIN SYSTEM


AVSIN SYSTEM
ADMINISTRATIVE SEGMENT
PROGRAM PRODUCTION SEGMENT
NON-PROFIT INSTRUCTIONAL SATELLITE CORPORATION CONTROLLING
A. Central Ground-Based Broadcasting Stations
B. Satellite or Necessary Satellite Channels
C. Reception Equipment in Schools, Learning Centers, Ground Reception Centers
D. Computerized Dial Access Ordering and Accounting Systems
AUDIO - VISUAL MANUFACTURERS PRODUCERS OF INSTRUCTIONAL MATERIALS (BOTH PUBLIC AND PRIVATE)

requirements with certainty (see Section III. C.), our thinking has been primarily along the lines of a dedicated instructional satellite with closer relation to public broadcasting than to commercial interests. Furthermore, the primary thrust for a system like AVSIN is likely to come from non-commercial interests. Therefore, the establishment of a nonprofit corporation similar to the Corporation for Public Broadcasting but with the capacity to own and operate satellite facilities appears to be the most appropriate organizational method at this time.

Another important organizational issue revolves around which existing entities, if any, are likely to provide leadership or assume ownership of the non-profit AVSIN Corporation. The Corporation for Public Broadcasting is prohibited by law from ownership or operation of any TV or radio broadcast station, system, network or interconnection. In 1969, the Public Broadcasting Service (PBS) was created with funds from CPB and the Ford Foundation to provide management of networking and interconnection facilities for Public Television.[16] PBS thus serves as a networking arm while PTV programming is provided primarily by organizations such as the new Educational Broadcasting Corporation formed by the consolidation of National Educational Television (NET) and Station WNDT (TV), New York.[17]

CPB has placed little emphasis on the interconnection of individual educational institutions for large scale development and distribution of instructional programming. Recently, a report entitled "Instructional Broadcasting: A Design for the Future"[18] was prepared for CPB which recommends that CPB assume an active role in assisting the development of instructional television. Thus, it is possible that CPB will become a more significant factor in instructional as opposed to just public television in the future.*

However, there are a large number of other interests in the instructional television and telecommunications field. Foremost among these is the United States Office of Education. In addition, there are organizations such as the National Instructional Television Center in Bloomington, Indiana; the Interuniversity Communications Council; the Joint Council on Educational Telecommunications; software producers and libraries such as MPATI and Great Plains Regional Instructional Television Library Project; the Children's Television Workshop which is entering the field with a new reading program "The Electric Company" designed for seven to ten year olds; not to mention various state, local and regional educational agencies.

A key issue confronting the development of a large-scale instructional satellite system is how to bring together the many and varied interests in instructional programming and telecommunications into an over-all national framework that provides services which can help improve U. S. education while retaining local and regional identity and control. We have not presumed at this stage to make any recommendations concerning how existing organizations might relate to the proposed AVSIN Corporation. It may be that an entirely new entity is the best solution, paralleling the creation of CPB. Further studies are required.

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*We use the convention; Public TV + Instructional TV = Educational TV in this memorandum.

C. AVSIN System Operation

The over-all system would operate as follows. The school or learning center contracts to lease the necessary reception equipment from the AVSIN Corporation, paying the corporation on a monthly basis.* The corporation installs the reception equipment and provides for its maintenance and upkeep. Each teacher is provided with a catalog listing the programs available for delivery. For example, if the teacher needs a curriculum for third-grade mathematics she refers to that section to determine what is available. The teacher chooses one of the programs, noting the identification number and price. This request is channeled through the school's administrative secretary. The latter calls a central computer. He keys in hi school's identification number followed by the program's identification numbers. For a continous curriculum**, this order might be placed once or twice a semester. Supplementary or enrichment programming may be ordered in this manner on a twenty-four hour demand basis. In any case, the computer confirms or denies the availability of the program material.

Once confirmation has been granted, the computer automatically bills the school for the material and credits the account of the material's producer. The order is then transmitted along with the school's identification number to the distribution/transmission center. Preceeding the broadcast of the program is a list of all the identification numbers of all the schools requesting that particular program. The transmission of these identification symbols selectively activates the automatic recording terminals in those schools which have ordered that particular program. The next day the teacher goes to the school's audio-visual center to find the tape ready for previewing, editing, or dubbing. She may then arrange with the AV coordinator for the playback of the tape at anytime the program is needed in the educational process.

D. Management of the AVSIN System

Figure 4 shows the proposed management structure for the AVSIN system.

The selection of the Board of Directors for AVSIN should be based on the two major goals of the Corporation: first, to provide the most effective method of providing access by the classroom teacher to a large variety of quality audio-visual material and second, to deliver that material at the lowest possible cost. These two criteria and the understanding that after

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* It has also been suggested that the schools be able to purchase and own the necessary equipment. Alternative possibilities are discussed in Section II. E.

**The term "continuous curriculum" refers to the audio-visual equivalent of a textbook; that is, a core curriculum that is used continuously throughout the school year to teach a specific subject such as third-grade mathematics. We are assuming, therefore, that suitable materials will be developed and utilized--two extremely important issues.

FIGURE 4

MANAGEMENT STRUCTURE FOR AVSIN

Instructional Satellite Corporation

Board of Directors (Total 15)*

3 Appointed By The President

6 Elected From The Educational Community

6 Elected From The Business Community

* Chairman Designated By the President

Advisory Board

Representatives From: HEW, NASA, FCC, ICC, JCET, CPB, NIT, etc.

President of AVSIN

Coordinator For Ground Systems Management

- Reception Equipment Division
  - Advisory Panel
- Accessing and Accounting Division
  - Advisory Panel

Coordinator For Space Systems Management

- Satellite Control Division
- Distribution/Transmission Division
  - Advisory Panel

the initial capital investment, the Corporation should provide for its own economic maintenance and growth have led us to recommend that the Board of Directors be made up evenly between professional educators and experienced businessmen with the addition of an unaligned segment appointed by the President of the United States. A ratio of 6-6-3 between education, business, and presidential appointees would appear to be adequate. The Chairman of the Board of Directors would be designated by the President of the United States.

The Board of Directors would receive advice from an Advisory Board whose duties would be to keep the Board informed on scientific advancements and managerial problems in the instructional satellite field. The Advisory Board would be made up of representatives from NASA, FCC, HEW, ICC, CPB, NIT and other relevant agencies.

The President of the Corporation would be selected by the Board of Directors to serve as long as it pleases the Board. The management of the corporation would be carried out through the President and his two major assistants--the Coordinator for Ground Systems Management and the Coordinator for Space Systems Management. These Coordinators would be selected by the Board of Directors on the advice of the Advisory Board.

The Coordinator for Space Systems Management would oversee two component divisions: the Satellite Control Division and the Distribution/Transmission Division. The Satellite Control Division would work closely with NASA in the development of the necessary technical requirements for the satellite, its launch, maintenance, and possible emergency replacement. The Distribution/Transmission Division would make the necessary signal relays between the central broadcasting center or centers and the satellite.* In addition, the Coordinator would also draw upon the assistance of an advisory panel of educators to assure the proper coordination of technical components so as to meet educational needs.

The Coordinator for Ground Systems Management will coordinate the activities of two component divisions; the Reception Equipment Division and the Accessing and Accounting Division. The Coordinator would receive assistance from advisory panels in each of these areas.

E. Equipment Provision

As we initially conceived of the system, the AVSIN corporation would have complete control over all the reception terminals in the schools or learning centers. The corporation would lease this equipment on a monthly basis and provide for its installation and maintenance. The reasons for this are several. First, we estimate the cost of the reception equipment to vary over a wide range, depending on the size and flexibility of the

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*It has been pointed out that these two functions, Satellite Control and Distribution/Transmission, could be handled by the same entity.

installation. Leasing of the equipment will make it possible to amortize equipment cost over a longer period of time and to enable less-affluent schools in outlying areas to afford the equipment. Second, it is unlikely that installation and maintenance of such equipment could be handled by the local TV repair man. It will be necessary in the mode of distribution of Alternative No. 2, direct reception by schools and learning centers, to secure, aim, and protect a special roof-top antenna. In addition, for many installations, the receiving terminal will probably include microwave converters, and special video signal recording and storage units. These will demand the attention of a trained service man. Third, by providing for maintenance, schools are guaranteed quick repair service in case of breakdown. Few schools would be willing to invest in a complex ITV reception system if its reliability quotient is low. Fourth, the machine will automatically activate its recording units on command from the satellite when program material the school has ordered is being broadcast. By retaining complete control over the reception terminal, the corporation can prevent unauthorized tampering of equipment to pick up programs the user has not paid for. By leasing equipment the corporation guarantees proper installation, and quick and efficient repairs. The school benefits by having an easier method for paying off equipment and the corporation is assured that everyone who is utilizing the service is paying for it.

However, a case can also be made for allowing some schools and school districts to own reception equipment. The development and distribution of computers and photocopiers permitted both leasing and ownership by the user, with provision for maintenance in either case. In the case of MPATI[9], unauthorized "free-loading" was one of a number of factors which led to the demise of the Midwest airborne television experiment. MPATI operated in the UHF broadcast band which made unauthorized reception both easy and legal. These latter two conditions would not necessarily hold for a satellite distribution system organized and operating like a common carrier in, say, the 2500 MHz region.

Another important point to consider is that, with the exception of distribution by satellite to remote, rural areas, the predominant mode of satellite-to-ground-to-school distribution may involve reception of signals by central ground reception centers followed by processing and distribution to TV sets, consoles and head sets in schools via already existing cable, ITFS and other facilities. Thus, ground equipment requirements for a system such as AVSIN and, therefore, overall systems costs very much depend on what is already extant at the time. Careful further planning and cost analyses are required as well as an assessment of the role of satellites in the overall instructional telecommunications mix.

F. Accessing and Delivery

An accessing and delivery system which provides fast and reliable service at reasonable cost is a key element in the AVSIN system. The inability of educational motion pictures to make a significant impact on education is due to the fact that they are too costly to buy outright. Films must be ordered sometimes months in advance and even then there is no insurance they will arrive on time. The teacher has access to the film for only a short period of time, usually one or two days before it must be

shipped back to the distributor at the school's expense. Because of these characteristics, teachers generally use films on a one shot enrichment basis to supplement material already covered in the classroom. Unreliability, high cost, and the inability to replay the film at a later date for review make the film medium unsuitable for use in teaching basic curricula such as mathematics or reading where continuous everyday reliability is required.

The AVSIN system is designed to overcome these problems so as to place the material at the teacher's disposal on a demand access basis.

G. Continuous Curriculum Access

Because of the need for advanced planning, budgeting, and the ordering of textbooks, teachers and schools generally choose their basic curriculum approach from six to nine months in advance of the coming school year. The AVSIN system is designed to permit the equivalent kind of curriculum planning to be made available to the educational user. The overall goal of the system is to utilize the satellite as the distribution mechanism for providing low cost, reliable, and easily scheduled* audio-visual materials to schools in both rural and urban areas.

In selecting the appropriate program series, the curriculum committee of a school would first refer to the AVSIN Directory for the subject and approximate grade level. A sample Directory page is shown as Figure 5. The Directory would list the program series available in that subject area. Included are the name of the producing organization, a brief summary of the material covered, the pedagogical approach, and the production technique used. This information would be cross-referenced with data on the number of programs in the series, the time of each segment, if teachers guides, workbooks, test sheets, and supplementary materials would be provided by the program producer, and the cost of the series for the number of students involved.

If the curriculum committee was interested in a particular series, it could use the AVSIN access system to request more literature, a sample program or make an appointment to talk to a company representative. By simply dialing the AVSIN computer system on a touch-tone telephone (at no expense to the school, with the AVSIN center using an INWATS system) and keying in their school's identification code and the code number of the information desired, the material will be automatically relayed via satellite. The sample program would be delivered and automatically recorded in the school** within twenty-four hours at the expense of the program

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* Video-tape can be scheduled and replayed at the teacher's or even the student's convenience. However, the costs of building in such flexibility must be carefully considered.

**The description in this Section is based upon having automatic recording equipment in the schools. The costs of having this kind of capability may turn out to be such that other alternatives such as real-time programming and redistribution from central reception points must also be considered.

HYPOTHETICAL SAMPLE

FIGURE 5. SAMPLE PAGE FROM HYPOTHETICAL AVSIN DIRECTORY

	Number of Programs	Cost per 30 Students	Cost per 90 Students	Cost for Over 120 Students	Teacher's Guides	Workbooks	Test Sheets	Supplementary Materials	Sample Program Available	Literature Available	Company Rep. Available	Additional Information
Westernhouse Learning Corp. Series ID. Number-(133-842) Summary-Review: Addition, Subtraction. New Material-Long Division, Multiplication 1 x 12 Approach-New Math Technique-Still Picture and Audio	90 15 min. each	$132	$210	$260	Yes	Yes	No	No	Yes ID. 425	Yes ID. 426	Yes ID. 427	
Old York State ITV System Series ID. Number-(144-896) Summary-Advanced Multiplication Beginning Fractions Approach-Standard Math Technique-Full Motion and Audio	45 20 min. each	$152	$245	$320	Yes	No	Yes	No	Yes ID. 323	Yes ID. 324	No	Available to Old York State Schools at Reduced Rates
Lumbia Education Division Series ID. Number-(155-822) Summary-Review: Multiplication 1 x 2, and Long Division. New Material-Advanced Multiplication, Fractions. Approach-Lumbia Special Technique-Still Picture and Audio	90 18 min. each	$150	$200	$250	Yes	No	No	Yes	Yes ID, 182	Yes ID. 183	Yes ID. 184	HYPOTHETICAL SAMPLE

producer. Written material would be relayed in facsimile form via satellite direct to the school or mailed by the producer. If a company representative is desired, the computer will relay that information to the company for further action. Using the AVSIN system, the once tedious and time-consuming process of evaluating possible curricula is now made relatively easy and efficient.

Once a curriculum series is ordered by the school it is delivered on a weekly basis, e.g., the series is transmitted in blocks of five to seven programs via satellite and automatically recorded in the school. The teacher may schedule these programs for replay at any time in the educational process she desires, repeating them for review or for students who missed them due to illness. While it is possible that a complete series of programs could be stored and kept on hand for easy access in an individual school, this possibility must be balanced against the cost of video-tape and the problems of storage and cataloging large amounts of material. The latter capability might develop in central ground reception centers but it is doubtful if individual schools could store such materials for any significant length of time. We have assumed that in Alternative No. 2 (see Section II. A.) individual schools with recording and playback equipment would need to erase old material and record new material on a seven to ten day basis. This would give any teacher a seven to ten-day access to any block of five to seven programs of a continuous series before the need to reuse the video-tape would arise. If a teacher found that she needed a previous program that had already been erased, she could reorder it over the twenty-four hour demand access system.

H. Demand Access

While the major segment of AVSIN's distribution capacity would be utilized by continuous curriculum demands, it would be desirable if the system had the added capacity to supply supplementary and enrichment programming on a twenty-four hour demand basis. Such a capability will require adequate bandwidth space and a minimum overall demand.

In this way the teacher may add new material to the learning process on short notice as the interest of the students develops along various lines. If the class should show an extended interest in any particular area, for example microscopic plant life, the teacher could refer to the AVSIN Directory for possible programs in this area. The Directory would supply the program's name and identification code, a description of the program, its running time, production technique, and cost. The teacher would select the appropriate program, check to make sure its cost is within her weekly audio-visual budget, then relay the request to an administrative secretary for final approval and ordering. Using the standard AVSIN procedure the administrative secretary would complete the touch tone telephone-computer linkage and the order would be placed and filled automatically that night.

I. Accounting and Cost Allocations

The AVSIN accounting system will be automatically linked to the previously described accessing system. After a school has ordered a curriculum series or individual program and its broadcast has been confirmed, the computer will automatically charge the school's account and credit the producer's account. The computer can even send the school's monthly statements direct to the school over the facsimile system. The system's efficiency and speed are obvious; it saves time and does not rely on the mail system. In addition, it insures that materials producer's royalty rights are completely protected. Because the computer controls the activation of the recording terminals in each school, no organization can receive a program without first paying for it. However, the expense associated with providing this service remains to be examined.

The cost of supporting the AVSIN system will be borne by the three entities involved in the process; the AVSIN corporation, the educational user, and the audio-visual materials producer. A preliminary discussion of costs and financing is presented in Section III.

J. Ground Distribution Alternatives and Trade Offs

Not all schools or school systems are going to need or want direct-to-school broadcast of instructional television via satellite. It may not be desirable in many cases to give the individual teacher complete control over curriculum in the classroom. In some areas ITV may be used by principals or district supervisors as a means of upgrading curriculum where poor or unqualified teachers are the only resource available. In addition, the cost of numerous reception terminals in a large school district may make it more economical to establish one master reception terminal which retransmits programs to the schools.

Let us consider four different alternative ground reception arrangements, all compatible with AVSIN design considerations (Table 1), but differing in their distribution structure, cost implications, and in their utilization by and impact on schools. These are:

Alternative No. 1. Direct reception of real-time satellite signals for instantaneous viewing in schools and learning centers. Such a scheme avoids the cost of having recording and playback equipment in each school as in Alternative No. 2.

Alternative No. 2. This is the predominant mode used in connection with the previous description of the AVSIN system in Section II, namely, direct broadcasting to the school for recording and playback at the teacher's request.

Alternative No. 3. This scheme involves the establishment of a master reception center which would receive and record programs and relay them via ITFS or cable to their appropriate schools for recording and eventual replay in the classroom. The advantage here is the cost avoided in establishing numerous individual reception terminals in each school. Whether this advantage is sustained for all combinations of geography, terrain and population distributions remains to be determined.

Alternative No. 4. This scheme also involves a master terminal. However, in this case the programs are relayed direct to the classroom TV set without being recorded in the school for replay, thus avoiding the costs of individual school recording and playback equipment incurred in Alternative No. 3.

The costing of each of these satellite-to-ground-to-school distribution schemes is beyond the scope of this memorandum. Costs depend, in part, upon the current and future availability of existing ground distribution facilities and reception equipment accessible to schools which might be compatible with signals from a satellite. Relevant information is now being developed by Barnett in the Washington University satellite-education project in connection with a study of opportunities, breakeven costs and the time sequence for development of various delivery systems (cable, EVR, ITFS, satellite) for instructional television.

Table 2 provides an assessment of educational utilization factors for the four alternative distribution schemes. It can be seen that Alternative No. 2, direct to school broadcast, provides strong control of curriculum at the local school level. Because of this feature, its chances for teacher acceptance are high and it can cater to the individual needs of the school. In addition, accessing and scheduling are excellent. From a supervisor's point of view this system would work well where competent teachers were available to make good decisions on individual curriculum needs in the classroom.

Alternative No. 3 may weaken the teacher's control over individual classroom planning, depending on who makes the final curriculum decision. If the teacher is the final curriculum authority, her position is still relatively strong. If the local superintendent of schools chooses the curriculum or must pass final approval on programming, the teacher's position is greatly weakened. However, by using video recorders in the schools, the teachers maintain the option of previewing and editing material before classroom presentation. The VTR's also help preserve accessibility and easy scheduling by providing 24 hours recording and easy replay, but the time delay in indirect reception is not as efficient as direct access. This scheme could be used where a supervisor or school board desires to maintain a certain level of control over curriculum and planning but still desires to preserve some degree of local control and self-determination on the part of the teachers.

Scheme No. 4 is one of centralized control program planning. It begins and ends in the district center and materials are broadcast direct to classroom sets without preview or adoption by the local principal or teacher. Using direct broadcast means placing a severe limitation on scheduling and access. Reception of program material would be limited to the six-hour school day and without VTR's, the replay of programs for slow or sick students would not be possible. Alternative No. 3 would appear to be applicable in areas of extremely low teacher quality or where the political situation demands strong centralized control of curriculum.

Alternative No. 1 appears to be the least satisfactory alternative in terms of the factors assessed in Table 2. Direct-to-school distribution to schools for instantaneous viewing implies that the schools in question must be willing to accept programs as they are with much less control and

TABLE 2. EDUCATIONAL ASSESSMENT OF FOUR SATELLITE-TO-GROUND-TO-SCHOOL DISTRIBUTION ALTERNATIVES

	Alternative No. 1 Direct to School For Instantaneous Viewing	Alternative No. 2 Direct to School For Recording And Replay	Alternative No. 3 Master Terminal For Relay To School For Recording	Alternative No. 4 Master Terminal For Relay Direct To Classroom Sets
Teachers' Control	Poor	Excellent	Good	Poor
School Principals' Control	Poor	Good	Fair	Poor
District Superintendents' Control	Poor	Poor	Good	Excellent
Teacher Acceptance	Poor	Excellent	Fair	Poor
Responsiveness to Individual School Needs	Poor	Excellent	Good	Poor
Scheduling Flexibility	Poor	Excellent	Good	Poor

flexibility if extensive use is to be made of instructional offerings in such a system. This alternative is appropriate when strong control of educational programming is desired by a central educational authority. Alternative No. 1 might find its best acceptance in a developing country which has yet to develop an extensive educational infrastructure or in areas in which the service to be provided greatly improves the quality and quantity of instruction. This analysis needs to be qualified depending upon how the instructional offerings are used, that is for supplementary or core instruction and depending upon the quantity, quality and frequency of program offerings.

The educational utilization factors assessed in Table II by no means exhausts the possible factors to be considered in a more detailed, comprehensive cost-benefit analysis which remains to be performed.

III. FINANCING THE AVSIN SYSTEM

A. Cost and the AVSIN Corporation

The initial source of funds for the establishment of AVSIN will undoubtedly need to come from the federal government. Considering the public nature of the corporation and the service it will provide to the entire educational community, a request for federal funds does not seem unreasonable. This federal funding should cover the fixed capital cost of the system including the cost of launching a satellite, the development of unique receiving equipment, and the establishment of an administrative structure.

The Board of Directors should be charged with maintaining the corporation on a self-supporting basis after the fixed costs have been paid. These operating costs may be included in the leasing fees charged to the educational user or as a tax on each program ordered. The corporation may also find it feasible to charge the material's producer for the right to market his program over the system. In addition, the corporation would be free to accept funds or donations from any public or private organization. In any case, the corporation should be an economically viable organization with sufficient funds for research and expansion.

B. Cost and the Educational User

It is hoped that the cost to the educational user can be kept to a minimum so as to insure that optimal utilization will not be hindered on financial grounds. The basic economic assumption behind an instructional satellite is that it can distribute instructional material over large areas to large populations at relatively low cost. The major capital investment will be made by the corporation. However, the cost of the reception equipment modules will have to be borne by the users, possibly in the form of installation and monthly leasing charges. Costs for reception equipment are estimated to vary, depending on capacity and complexity, and will be examined in a future study. If ownership of ground reception equipment is not possible, the educational institution will be expected to pay an installation fee and a monthly leasing fee which will be based on the size and the type of service desired. Alternatively, a fee might be assessed for services rendered by the corporation. In addition, the schools will have to pay for the programs they order. It is hoped that by putting the production of programming on a commercial open-market basis, program software costs will be kept at a minimum by the forces of competition, thus keeping cost to the user minimal.

The ability of educational users to pay for the services described above may be a major stumbling block to utilization of the system. More affluent school districts will be in a better position to pay the necessary fees than less affluent schools in remote areas which might benefit the most. To rectify this situation and provide equality of educational opportunity may require either subsidization of poorer school districts from sources outside the AVSIN system or a system of charges based both upon per student use and upon need. This matter clearly requires careful further consideration.

C. Cost and the Materials Producer; Software Requirements

There is need to try to estimate as accurately as possible the software production requirements for an instructional satellite system. The issue is a difficult one because there is little past experience to go by and the requirements themselves may be influenced by the systems which come into being. For example, a commercial satellite may offer a limited number of channels for educational/instructional use which permits a limited number of program hours, thus restricting the potential utilization. On the other hand, a satellite dedicated solely for educational/instructional use might offer a much greater programming capacity which in turn provides greater opportunity and flexibility for utilization. Efforts are now underway to try to define, more precisely than before, requirements for educational satellite services.

In this section, we will consider software requirements for instructional television. The Commission on Instructional Technology[19] reporting in January of 1970 found that not more than 5% of classroom time at all levels of American education was in any way affected by the newer media of television, films, programed tapes, etc. In addition, a recent study of the utilization of ITV in sixteen urban centers[20] shows that television utilization is less than 3% of actual classroom time. The data appear to show that except for a few well planned, innovative and adequately financed programs, the television medium has yet to have a significant impact on education. On the other hand, an exploration of the future in educational technology concludes that "extensive development and widespread adoption of educational technology will occur during the late seventies and eighties."[21] In what follows, we will derive estimates for instructional television which fall between present utilization and predicted widespread adoption, recognizing that the development and low-cost distribution of an adequate quantity of quality software can markedly affect utilization levels. We have not considered instructional requirements for other, newer technologies such as computer-assisted instruction in this memorandum.

In his study of the costs of educational media systems, Sovereign[22] estimates that between 1,000 and 1,600 program hours are required for a year of educational use in regions which vary in size from a local school district to a region of approximately 10 million students. These calculations are based upon an assumed television use during 10% of the students actual classroom time. Estimates in this Section exclude higher education.

Much larger estimates of programming requirements are arrived at if one follows the approach of Wagner[8], who estimated that a minimum of 50,000 hours of instructional television would be needed to satisfy the needs of a national system. The fundamental differences which account for the increase over Sovereign's estimates in Wagner's study are 1) it is assumed that 1/3 of the average elementary school day is devoted to televised instruction and 2) that a variety of teaching approaches will be required. For example, in the illustrative calculation shown in Table 3, which follows Wagner's approach, it is assumed that three ability tracks and two pedagogical approaches will be required for grades 1-12 to satisfy the nation's pedagogical needs. This increases the program requirements by a factor of six over a one-track, one pedagogical approach curriculum.

In Hagerstown, Maryland,[23] it was reported that televised instruction constituted 10-14% of classroom time in elementary school, 35% in grades 7 and 8, and 17% in grades 9-12, somewhat higher than Sovereign's estimates but nowhere near one-third utilization at all grade levels.

If one accepts the estimate of programming hours for a national system as shown on Table 3, 40,000 hours, the cost to produce this quantity of high quality material becomes sizable.* Although until recently, instructional television programming costs have been of the order of $1,000-2,000/hour or less, there has been a growing realization that quality instructional and public television requires budgets that are more nearly those of commercial television.** If we take the figure of $40,000 per hour, which is the estimated production cost of Sesame Street[18], a software production estimate of 1.6 billion dollars is obtained for a large-scale ITV system. If one assumes an annual requirement of 20% new programming per year to maintain an inventory of 40,000 hours of current program material, this represents an investment of 320 million dollars per year. This figure is a sizable number, one which could be potentially attractive to commercial as well as to non-commercial audiovisual producers. The AVSIN system could have the effect of providing incentives for more emphasis on software rather than hardware production. However, the economics require careful scrutiny as does the projection of the number of programming hours. Because the schools themselves must pay for the software used, it is important to examine whether at a time of taxpayers revolts and growing teacher militancy, one can reasonably expect even the small per student cost represented by the above figures to be available. Estimates of future educational budget fractions which might be available for technology and of the costs and benefits derivable from selected educational television utilization situations are being carried out to shed further light on the question of both programming requirements and markets.

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* In interviewing teachers on their attitudes towards ITV, it was found that it was not the use of the television medium, but the quality of programming that they most frequently criticized.[8] Teachers reported that the principal block to ITV utilization was the inability to obtain enough high quality software in sufficient quantity to maintain continuous use.

**The following testimony by Father John Culkin speaks eloquently to this point:[24] "The programing that the student sees on commercial television costs approximately 80,000 dollars.... The production cost for the average half-hour program being watched by students in school is less than 150 dollars. So he lives on whatever appears on commercial television, not just entertainment, and which is produced for him by people with 80,000 dollars per half hour and then he goes to school where the real important things are supposed to be happening and he sees programming which costs 150 dollars per half hour to produce and there is a difference not only in the budgeting but in the quality and competence and zap of the programs. ...all I am suggesting is that we bring the educators into the real world where they can be the slightest bit competitive for the attention of the student. It is not even a real ball game now. What you get for 150 dollars per half hour is not very good instruction and it is not very good TV and all the rhetoric in the world about these new media and their power to do things for kids will be completely useless unless we implement this very unromantic area of television called school television because nobody cares very much about it."

TABLE 3

ANNUAL SOFTWARE COST ESTIMATE

FOR INSTRUCTIONAL SATELLITE SYSTEM

LET TV = 1/3 of 6 HOURS PER DAY CLASSROOM USE

FOR SIX-GRADE SCHOOL = 60 HOURS PER WEEK OF PROGRAMMING
= 2160 HOURS PER YEAR

FOR SECONDARY SCHOOLS 100 COURSES OFFERED

IF EACH 45 MINUTE COURSE UTILIZED 15 MINUTES OF TV:

NEED 25 HOURS PER DAY OF PROGRAMMING

OR = 4500 HOURS PER YEAR

TOTAL = 2160 + 4500 = 6660 HOURS PER YEAR

IF ASSUME 3 ABILITY TRACKS AND 2 ALTERNATIVE PEDAGOGICAL APPROACHES:

= 40,000 HOURS PER YEAR

AT A PRODUCTION COST OF $40,000 PER HOUR:

COST OF 40,000 HOUR INVENTORY = 40,000 HOURS x $40,000 PER HOUR

= $1.6 BILLION

IF ASSUME A REPLACEMENT RATE OF 20% NEW MATERIAL PER YEAR:

ANNUAL COST = $320,000,000 PER YEAR

It is instructive to compare the above costs with costs associated with storage on video tape. It is highly unlikely that any single school could afford to produce or store the estimated 6,660 hours of material. Even at the district level, the cost of storing this amount of tape would be sizable. For example, if one uses professional quality 2" Quad tape, the tape cost is $200 per hour of programming. This cost could be reduced to $60 per hour if 1-1/2" Helical Scan tape is used and might even be reduced further with the advent of tapes for low-cost home video recording units and the development of new high-energized video tapes. If we use the $60 per hour figure, the tape cost for 6,660 hours of programming (one track, one pedagogical approach) is $400,000. For some 20,000 school districts in the U. S., this represents an investment of 8 billion dollars. In the AVSIN system, a much smaller tape inventory is contemplated. (See Section II. G.)

The AVSIN system places the costs of developing the necessary software not on the Corporation, not on the educational user, but instead on the audio visual media industry. The competitive program production aspect of the AVSIN system may serve to redirect the interests of industry with interests in the education market away from a proliferation of incompatible hardware and towards the development of quality software which is essential for meeting educational needs.

After the material is produced, AVSIN will list its availability in its general directory for a basic service fee. The materials' producer will supply the necessary master copies of the product free of charge to the central broadcast center. The Corporation will charge the producer for transmission/distribution of sample programs to interested buyers. It is also likely that to make the distribution of any particular curriculum series or program economical to the Corporation, a set minimum number of buyers must be found for the material. If this minimum can not be reached,the materials' producer will have to decide if he wants to cancel his program or pay the difference to have his material aired. He is also free to advertise his product by conventional means at his own cost. In this way the risk of producing a program which is marketable lays with the producer.

In a previous discussion of cost allocations, the rationale for placing the expenses of research and development on the commercial audio-visual industry as a whole was explained. It was felt that industry would provide high quality software programming in sufficient quantity if a low cost economical system of distribution could be devised to reach the vast educational market. The increased interest shown by companies in education through performance contracting[25] leads one to suspect that a system such as AVSIN with much greater distribution capacity might attract considerable interest.

To deliver the previously discussed 40,000 hours of continuous curriculum material, the distribution system would need to transmit approximately 148 hours of material a day (September to June school year = 270 days; 40,000/270 = 148 hours per day). To handle this requirement seven full motion television channels would be required (148 hours/24 hours per day = 6+). These calculations indicate that the availability of one or two channels from a commercial satellite may not suffice to meet

future requirements and opportunities of the educational community for instructional television and a dedicated satellite may be required. The question of spectrum availability is currently being resolved at the June 1971 WARC Conference.

In addition to instructional television, there are other media and data which could be used in the schools that a dedicated satellite system could transmit. These include audio, facsimile and still-picture television as well as digital data for computer-aided instruction, research and administration. Bandwidth requirements and associated distribution costs remain to be determined.

D. Overall System Economics

This Section will simply outline some key considerations associated with determining the economic feasibility of the AVSIN system. The necessary economic analysis remains to be performed.

1. Satellite and Ground Equipment Costs

Recent estimates of the costs of a variety of broadcasting satellite systems for community reception indicate total systems costs in the range from 54 to 310 million dollars.[26] This represents a per pupil cost of approximately 1 to 5 dollars, based upon a total U. S. school population of 59 million.[27] A February, 1971 study performed by General Electric for the Corporation for Public Broadcasting[28] estimates investment costs of 126 to 188 million dollars for three different satellite systems capable of distributing signals to all 100,000 U. S. schools and to 200 ETV stations. These costs include estimates of costs of individual reception terminals in each school, i.e. antennas and front-ends, but do not include the cost of in-school distribution or television sets. The above estimates are included simply to give the order of magnitude of the costs which would have to be borne in a system such as AVSIN. Somewhat higher costs will be encountered if extensive use is made of recording and playback equipment in each school.*

2. Programming Costs

This cost, which is to be borne in the AVSIN scheme by the software producers, depends upon the number of programming hours required and the program production costs, as was discussed in the previous section. If the annual recurring estimate of $320,000,000 per year is used, this is a per pupil cost of approximately $5.

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*A recent Office of Education Study[29] indicates that 75% of all public schools have television receivers, that the average number of sets per school is 2.8, and that 26% of all public schools have video tape recorders. The availability of this equipment may lower system costs, provided that the equipment is compatible.

A basic question which has to be addressed is whether there will be enough incentive for companies to enter the software production field. Estimates are required of how much schools might be willing to pay for programming and whether production costs can be kept within that range. Presumably, competition may help reduce programming costs. Furthermore, the prospects of penetrating a large number of schools with instructional software may prove appealing to companies. The alternative is the development of the necessary software in the public domain through federal funding.* The proposed AVSIN system is designed to accept software developed by both commercial and non-commercial organizations.

3. Spectrum Utilization Costs

Should spectrum space prove to be scarce, the AVSIN Corporation might establish a system of fees to charge the producer according to the integrated bandwidth-time required for the various forms of instructional material to be broadcast. For example, of the various audio-visual media depicted in Figure 2, the highest fees would be paid on full-motion television distribution because television uses the most spectrum space. The lowest fees would be on audio or facsimile transmission with still-picture television somewhere in between.

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*A book by Marke[30] provides an interesting, readable review of the issues of government-financed curriculum materials and public domain policy, reprography and intellectual property, and the information explosion and new technology.

IV. CONCLUDING REMARKS

In the preceding sections we have presented a preliminary description of a hypothetical large-scale instructional satellite system, concentrating on organizational, administrative, financial and policy issues. We have termed this study "preliminary" in that it is by no means meant to be a complete, final proposal for such a system. As has been stated previously, we have not explored technical and economic feasibility to any extent. We are issuing this memorandum at this stage both to stimulate discussion and research and to obtain feedback from interested outside parties.

If one leaves aside the question of system feasibility, we believe that this study contributes in the following ways. First, it summarizes information concerning previous studies, proposals, and agencies which is relevant in considering strategies for moving towards an operational educational satellite system. Second, it develops a set of design considerations--social, political, educational, administrative, economic--which provide a basis for system design. Third, by describing certain organizational and operational characteristics of a large-scale instructional satellite system in what is possibly excessive detail, we hope to provide the reader with insight both into the opportunities afforded by the technology as well as the complexity of issues involved in organizing such an effort. Fourth, key issues--the relation of non-profit vs. profit making organizations and the business vs. the educational community vs. the government to such a system, the issue of provision of and control of ground equipment and access, the question of requirements for and production of software, assessment of educational utilization characteristics of various satellite-to-ground-to-school distribution schemes--are all addressed and alternatives are explored. Fifth, in developing system concepts and instructional programming requirements, we have given heavy weight to the needs and requirements of the classroom teacher within the context of the overall U. S. educational structure.

Whereas it is probably too early to come to a definitive set of conclusions and recommendations, we offer the following points relative to a large-scale instructional satellite system which emerge from this study for further discussion and research:

1. We recommend separation of the administrative and program production aspects of the instructional satellite system.

2. We favor a cooperative public-private sector approach to an instructional satellite system with government funding for the satellite facilities and a competitive software framework which would permit access by both commercial and non-commercial program producers. The hope is that the market will be sufficient to provide incentives for the development of large amounts of quality software, a key requirement for a large-scale instructional satellite system.

3. We believe it important to view satellites as one portion of the total educational telecommunications mix. In particular, because systems costs are sensitive to ground equipment requirements, studies are needed of the present and projected availability of ground reception and distribution facilities to schools on both a regional and national basis which might be compatible with signals transmitted via a satellite.

4. We believe that if full advantage is to be taken of opportunities inherent in a large-scale instructional satellite system, a system solely dedicated to educational purposes is called for. Future studies of educational telecommunications requirements are likely to bear this conclusion out. Per pupil investment costs for such systems are usually estimated at a minute fraction of total per pupil educational expenditures. However, much more work of a cost-benefit nature is required, involving both evaluation of current utilization of instructional technology and new experiments, to develop the data which might be used to convince school administrators and teachers that at a time of tax-payers revolts and increasing teacher militancy, investments in educational technology are desirable.

5. We have recommended that a new non-profit satellite corporation, composed of educational, business and non-aligned interests be formed to give impetus to the development of large-scale instructional programming distribution via satellite. Although we have discussed relevant interests of a number of existing organizations, we have not come to any conclusions as yet as to which, if any, of these organizations might serve any or all of the functions to be assumed by the corporation.

6. We believe it important to give further consideration to how such a system might provide services and opportunities to schools in both rural and urban districts with below-average educational budgets.

7. Long-range political and social implications should be considered at the time technological innovations are proposed. The Appendix to this memorandum directs itself to this issue.

V. APPENDIX

LONG RANGE IMPLICATIONS OF SATELLITE-DISTRIBUTED EDUCATION

A. Political Implications

The AVSIN system involves two basic areas of political control; local independence and federal educational assistance. The AVSIN system is designed to reconcile these two factors.

The love-hate relationship between education and the federal government has been going on since the end of World War II. Educational institutions, both public and private, have continuosly sought federal assistance to help them meet the rising cost of instruction. However, they fear that federal aid will bring federal control. In addition, there is the sticky problem of federal aid to private education. Can tax dollars go to support private school systems? When the problem is related to ITV, the major issue becomes one of who will control programming and what will be its content. The local schools fear that they will be forced to accept a standardized program format along with federal assistance.

The AVSIN system addresses these issues by having Congress fund the program as a non-profit politically independent corporation. As an independent corporation, AVSIN can contract its services out to anyone who needs them, public or private. In this manner the federal government would have a way to underwrite improved education to all the schools in the nation. The corporation, functioning essentially like a common carrier, would have the right to lease its service to any organization which desires to rent a reception terminal no matter what their educational persuasion.

Furthermore because the corporation has absolutely no control over the content of the programs it carries there can be no claims that the federal government is dictating or controlling education content. All schools have the right to choose whatever programs meet their needs. The educational institution is in total control of what it delivers to its students. Thus by establishing AVSIN as a nonprofit corporation the federal government can extend educational opportunities into areas which were previously politically unreachable. Making program production independent from administration guarantees that no one will be able to dictate program content.

The long-term political implications of such a system require careful consideration. Instructional and other programming of interest to a particular special interest group could be distributed over wide areas. These groups could conceivably include American Indians, Spanish-Speaking Americans, Blacks, Parochial Schools and Segregated Academies. The system thus would appear to have the capability of promoting diversity, which may or may not be healthy depending upon ones special interest and point of view. Further, there will undoubtedly need to be some form of regulation of the AVSIN system in the public interest, even though no over-the-air broadcasting is contemplated. For example, one can not call someone and make threatening remarks over the telephone.

Another long-range political implication is the marked boost that such a system is likely to give to the use of audiovisual material in the schools. Text book publishers appear to be preparing for this eventuality anyway by diversifying into the media field. There are a number of issues related to commercial versus non-commercial, and copyright vs public domain software problems which require examination but which have not been considered here.

B. Social Implications

To gain an understanding of the possible long-range implications involved in satellite-distributed instruction, it is necessary to examine the problems involved in the development of instructional media and their relation to present trends in the American education system.* By "educational system" we mean not only "formal" education (primary, secondary, and post-secondary) but also "non-formal" processes, including special preschool education, on-the-job and in-service training, functional literacy classes, professional refresher courses, and special youth programs. These formal and nonformal educational activities collectively comprise the nation's total organized "educational system."

1. The Functions of Media

Media have functions which are socio-cultural in nature. These functions have been defined and divided into three basic areas; information, socialization, and mobilization.[3] The information function is the transmission and dissemination of information and essential knowledge, and the posing of alternative forms of economic, social, and political action. The socialization function is the communication of cultural norms and the transmission of values which orient a person toward proper modes of social interaction. The mobilization function is the process of persuasion and the development of loyalties and associations which are necessary for collective problem-solving.

Questions are seldom asked about the long-term consequences of media, such as its impact on student interest, morale, values and social relations. There is little information on the effects of media on the teaching staff, student body, or the educational institution as a whole. Yet these are the areas which, coupled with the organizational framework for utilizing media in the schools, could effect the acceptance or rejection of a large-scale satellite-distributed educational media program. These side effects of socialization and mobilization must be taken into account in determining the utilization of satellite technology along with the direct effects of the satellite's obvious ability to disseminate information.

2. The Social Environment

The impact of media on the educational system must be examined in light of the social environment within which it must operate. In America

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In discussing the term "media" and its relevance to education, our concern lies in the various forms of television and programmed instruction, as well as a variety of devices such as motion pictures, still-picture television, sound tapes, film strips, micro-film and slides, most of which have been used for many years. We have not considered computer-aided instruction in this memorandum although some of the following analysis is relevant.

this environment is predominantly urban and metropolitan in nature.* It is characterized by a multitude of social and economic needs which combine with a variety of cultural and ethnic backgrounds. Educational media are being forced to adapt to the multiple social and personal capacities of the student body and at the same time offer a curriculum with enough diversity to satisfy the varied need of the urban occupational structure. In this regard, the media are being used to satisfy an increasingly heterogenous audience. On the other hand, society demands that the functions of the new media--information, socialization, and mobilization--equally stress symbolic values and content which are unifying and inclusive in nature and promote social needs and interactions.[31] In general, educational media are "mass" by nature and encompass a wide audience. It is, therefore, necessary that media maintain some common denominator in form and content. The true challenge in the development of relevant media is in maintaining the proper balance between the need for specialized content and the importance of stressing homogeneous and unifying symbolism.

To a great extent, the problems of specialization and homogeneity are reflected in the American educational format. The first of these formats is called "standardized" education, that is, the acquisition of uniform basic skills on a mass basis to meet everyday technical and social needs. The second format is "individualized" or "problem-solving" education which stresses the differential treatment of students for the higher development of both technical and personal skills. These skills are emphasized in the socialization and mobilization functions as opposed to the standardized format which stresses the information function.

It is possible that the rapid introduction of an extensive program of instructional media, via satellite or traditional methods, will disproportionately emphasize the standardized format to the neglect of the equally important individualization need.** The results would be the utilization of media for the uniform treatment of broad categories of students in routine and in flexible curricula.

Given the economy and utility of using instructional media in a relatively standardized format, there arises the possibility that wide spread distribution of instruction via satellite will promote an increase in the social stratification of the educational system. Many of the poorer educational institutions (ghetto, rural, and some private schools) lose qualified staff to better financed schools or suffer from severe budget limitations. As a result, many schools could conceivably find it economically

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*Satellites offer the promise of improving rural telecommunications and thus can aid in halting the flight to metropolitan centers.

**Although true for television this would not be the case for computer-assisted instruction, the latter being geared for individualization.

profitable to sacrifice individualized problem-solving formats by supplementing their curricula with standardized ETV materials. The more affluent suburban schools that have the financial resources will supplement standardized curricula with personnel and equipment to promote individualization.

If these trends continue, they may lead to the development of a rigid, two-track, European-style system: standardized versus problem-solving education. This would promote a social dichotomy between the "have" and "have not" institutions. The "have not" schools of the ghetto minority groups would be relegated to the utilization of standardized formats which are best suited to the production of routine skills. The "have" schools with their greater financial resources would provide a problem-solving education for potentially creative elites in a special privileged setting.[31]

These trends do not inevitably have to continue. Standardization is not inherent to media expansion provided that a large variety of quality software can be developed and distributed to needy schools in ways which meet individual needs and provide flexibility. The AVSIN system as previously described has responded to the need to combat standardization to some extent. However, unless specific actions are taken to increase the ability of needy schools and school districts to utilize the system vis-a-vis their more affluent sister institutions, either through the AVSIN fee structure or some other form of subsidy external to the system itself, the technology is likely to be utilized to the fullest, most beneficial extent only by the more affluent schools. This is a situation which must be avoided.

3. Social Implications for the Disadvantaged

Many segments of population are grouped in physically or politically inaccessible areas where state and federal development programs are unable to reach or motivate them. The AVSIN system has the potential to reach widely dispersed groups such as migrant workers, Mexican-Americans, penal institutions, the rural poor and to provide these groups with specially programmed material to meet their varied cultural and educational needs.

When using the new media to educate disadvantaged groups, certain unique assets and liabilities become apparent. A review of the literature concerning media and the disadvantaged will help outline some of the issues involved.[32]

It has been found that media are useful in extending frames of reference and in providing models and motivation for the disadvantaged. A study of ETV's effect on 1600 Negro children in a Free School's project in Prince Edward County, Virginia, showed that school presentations of television programming and motion pictures served as important cultural events for these children because local theaters were segregated.[33] A special program called "Roundabout" for disadvantaged preschoolers in Washington, D. C., revealed that TV characters--non-teachers and non-professionals--can and do serve as effective models for children to emulate.[34]

Teachers participating in a New York public school project found that the effects of audio-visual instruction on students included increased attention, greater willingness to practice oral communication skills, and increased student question-and-answer exchanges in the classroom.[35] In a similar project where maximum flexibility and supply of media materials was made available, high teacher turnover dropped, student attendance increased, and disciplinary problems decreased. In addition, both teacher and student morale were high. [36]

These project studies point out the advantage of using media to provide disadvantaged students with a useful model to emulate and media's ability to help motivate students toward greater participation in the educational process. In urban ghetto schools where dropout rates are high, extensive utilization of suitable media could serve as a powerful force in motivating students to continue their education. These and other studies appear to demonstrate media's ability to reach disadvantaged students more effectively than traditional printed material.

However, teachers in these projects noted two serious problems: First, many excellent programs were wasted because teachers were not able to prepare supplementary pre-presentation and follow-up materials;[32] and second, many of the programs were irrelevant to the students' needs, learning styles, and life experiences. [32] In response to these needs the AVSIN system is designed, wherever possible, to enable teachers to prerecord instructional material in such a way as to make it easy for them to preview material before classroom presentation. During the previewing process, the teacher, possible with the help of a low-cost,video-cassette system, can prepare additional materials and edit the presentation to meet the specific needs and learning styles of his students. In this way, extraneous or irrelevant materials can be deleted before they reach the classroom. When multi-media materials are made easily available, as with the AVSIN system, students feel a sense of reality and self-determination in learning to learn. In many cases, this offers the student an escape from what he feels is the inertia of the self-contained supervised classroom.

In addition to their value to disadvantaged school children, audio-visual presentations have been shown to be effective in large-scale experiments in adult literacy training.[37] A project, conducted in Northern Alabama, involved six hundred students over forty years of age and emphasized practical application of literacy skills such as check writing, street-sign reading, and phone dialing. Comparison testing showed that television used in small-group viewing centers with the help of a proctor (not necessarily a skilled teacher) was as successful as direct teaching, in the areas of work knowledge and word discrimination. The results of this project help point out the value of establishing media centers for supplementary non-formal adult education programs. There are about ten million functional illiterates in the United States who could be reached by AVSIN programs in local community centers linked by cable or ITFS to master AVSIN receivers. These facilities could be used to provide evening courses in small business management, agricultural projects, secretarial skills, etc., to those people who work during the day or are beyond normal school age.

Viewing centers in schools or community centers, linked with AVSIN, appear to be a way of reaching many disadvantaged groups. A study to assess the possibility of using ETV to reach Spanish-speaking families in the Southwest showed that special Spanish-language programs failed to reach 60% of the study group.[38] Follow-up studies showed that many Mexican-American families did not have properly functioning TV sets; had less leisure time to watch TV; and in the case of large families, watching preferences were often in conflict. In many cases, varying ethnic and cultural groups have different viewing habits and preferences.[32]

Much of TV programming is irrelevant to the poor because it is out of touch with the reality of their lives. It is necessary to develop programming on subjects relevant to the needs of the poor such as legal aid information, low-cost budgeting plans, child health care, etc., and to present the information in the proper socio-cultural context. The problem is one of providing needed information to people who are not normally information seekers and who are not members of any organized unit such as the school classroom. One possible solution would be the use of AVSIN to distribute needed information to block committees headed by local volunteers, social workers, or even VISTA members. It may be possible for these block committees to organize special information courses where AVSIN would provide the bulk of the instructional material.

In summary it can be said that the new media, as implemented through the AVSIN system, are capable of both reaching and motivating many previously inaccessible minority and disadvantaged groups. This added dimension of the social implication of an instructional satellite system must be factored into the total overall cost-benefit analysis of such a project.

C. Educational Implications

In the American school system the pressures for adoption of new media have been strong (as have the resistances to such adoption) with little thought given to the resulting consequences. How satellite distributed instruction will be received and interact with the present educational infrastructure is difficult to assess because of the great diversity in structure and philosophies found in American education. The AVSIN distribution system was designed to be as flexible as possible, to meet the needs of a wide range of educations applications, and to be easily integrated into the various educational structures it must serve.* The introduction of AVSIN, or any comprehensive ITV system, will raise many questions about organizational control, curriculum flexibility, and professional standards. The following analysis is a discussion of the problems and issues that the implementation of an extensive instructional media system will have to face.

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*See Design Considerations in Table 1.

1. Systemic Resistance

"Token saturation" is the phrase coined[31] to illustrate the situation resulting from powerful pressures for introductive use of the new media, opposed by equally strong restraints on its utilization. It involves the purchasing of extensive instructional media systems, which are both impressive and expensive, with little or no actual utilization of the equipment. Token saturation and its result--underutilization--are often the reaction of administrators who have been pressured by school boards to innovate but are hoping to avoid undue disruption of their schools until effective administrative procedures are developed. Many times the professional rigidity of the teachers themselves leads to organizational sabotage of media projects. This reaction is generally due to lack of understanding by the teacher as to what role the media will play in his educational routine. Frequently, many teachers shun media devices because of lack of experience in the utilization and operation of the sometimes exceedingly complicated apparatus.

Many times media systems have built-in rigidities which make them unable to cope with the variable needs of large school systems. One of the reasons cited for the failure of the MPATI project was its inability to produce a flexible enough curriculum to meet the multiple needs of its users. In addition, many media systems make no allowance for remedial work by slower students or are incapable of handling the special needs of superior students. In short, administrative, professional, and most technical problems have greatly hindered the effective utilization of the instructional media.

In response to token saturation and resistance on the part of administrators, educators have combined with scientists and technicians to explore adaptive solutions for overcoming problems raised in the application of media. These solutions include: the restructuring of teaching tasks, programs for individual development, and the development of interpersonal feedback.[31]

In the area of restructuring teaching tasks, it must be remembered that, at times, media will at most play a modifying role and substitution for the teacher is usually not contemplated. The media will act as a supplementary tool available for easy manipulation by the teacher at the right time. The teacher who has ready access to a variety of educational media--television, slides, audio tapes, etc.--will be able to orchestrate his teaching procedure so as to provide the most effective form of communication at the proper time.

The AVSIN system is designed to make available to the teacher a vast storehouse of media material from which to satisfy his needs. If easy availability of scheduled materials can be provided, say by recorded programs nightly, and by rapid twenty-four hour access to specialized programming, the teacher is able to present instruction which is both creative and pertinent to the varied needs of his classes.

In addition, if AVSIN's material can be prerecorded, the teacher can preview materials before classroom presentation. AVSIN's facsimile unit could also provide written teachers guides and discussion questions to help prepare the teacher's presentation. AVSIN should be flexible enough to allow the teacher to articulate his personal needs, thus helping to avoid many of the problems of rigidity which lead to standardization of curriculum.

Teachers will have to be trained in the proper methods of coordinating media materials for classroom use. However, the teacher's job will be simplified if AVSIN utilizes normal television receivers and earphones linked to the classroom by cable from the school's receiving terminal where a technician will coordinate the replay of the material for the teacher. In this way, the teacher is not bothered by having to move his class to special viewing rooms or by having to waste time setting up and operating complicated projectors and slide machines. The technician, who may also be a media specialist, can act as cataloguer, librarian, supplier, and in-service trainer for the teachers. By making the physical presentation of media as easy as possible, the AVSIN system goes a long way to insuring its proper utilization.

The second response educators are making to combat standardization is in the area of designing media programs to meet the developmental needs of individual students. Attempts in this area have been frustrated by the very nature of the organized school system. The structure of the American educational cycle is one of the lock-step progression from one grade to the next according to chronological age, not mental ability. The use of media to educate large blocks of students in standard formats does not allow for individualized self-learning. The school should make it possible for the student to proceed beyond his grade level at his own speed or provide special assistance to help him overcome deficiencies. In response to this need, the AVSIN system should strive to provide the individual student with much the same flexibility in choosing study materials as it does the teacher. Superior students with more advanced interest would be able, with the help of their teacher, to develop their own curriculum using the twenty-four hour demand access capability of the AVSIN system. Computer-aided instruction may play an important role also. Individualization is thus limited by the number of television receivers, earphones and/or computer consoles in the classroom.

Another area of adaptive development has emphasized media presentations which avoid the loss of face-to-face interaction and feedback between students and teachers. Only if the teacher has personal contact with the student can he be sure that the material is relevant and accomplishing its task. Media specialists claim that the utilization of audio-visual devices will mean the reallocation of time in such a manner as to provide more time for interpersonal contact with individual students. This they feel is especially true in large classes where interpersonal interaction has in the past been impractical. As a counter-claim, it has been argued that much of the teacher's newly freed time is taken up in the organization

and coordination of media presentations. Studies are beginning to show that increases in teaching productivity resulting from the use of media occurs because the teacher is able to mobilize more resources in such a way as to promote a higher degree of student interaction in the educational process.[31] It has been found that the introduction of media actually forces the teacher to work harder in preparing and presenting classroom material. In this process it is the responsibility of the teacher to develop and maintain an effective system of interpersonal communications with students. The AVSIN program provides the teacher with a system for multi-media presentations of varied and easily accessible materials but it is the responsibility of the teacher to coordinate student activities and media materials for maximum effectiveness.

The effects of media on the personal self-esteem of the teacher is a highly important factor in promoting effective utilization and avoiding token acceptance. Some educators see the new media as a challenge to their classroom authority. Technology is resisted in education because it builds up new power centers and weakens traditional ones. They feel that their position is weakened by the intrusion of outside experts via the television screen. This view neglects the fact that, with the introduction of media, the teacher's role is transformed from that of an authoritarian to one of a professional coordinator of expert personnel and resources. By providing the greatest possible variety of high quality programming, the AVSIN system increases the professionalization of teachers by increasing their productivity and effectiveness, which in the long run may bring higher salaries and greater prestige.

To the American youth, the school system is the central focus of his daily life. Outside of the family, the school is the most important institution in a youth's cultural socialization. In the school the youth learns responsibility and begins to assimilate citizenship experience by emulating the examples set by teachers and administrators. The utilization of the new media plays an important part in setting the scene for educational socialization.[31] Media may be mismanaged in such a way as to weaken citizenship training by reducing the competence and authority of the teacher or by increasing standardization. If this results, the student will lack a respectable model to emulate and, especially in the case of ghetto schools with minority groups students, will feel his educational experience is irrelevant to his everyday life and needs. However, if the new media are used as outlined in the AVSIN program, teachers and administrators will have enough flexibility to express education with effective competence and autonomy. If the student feels the educational institution is providing him with an equal learning opportunity and individualized attention to his special needs, he is being appropriately prepared for participation in a democracy.

D. The Satellite as an Agent of Change

One of the prerequisites of this study was to develop an organizational structure to distribute instructional television which will have a meaningful impact on American education. Now it is time to examine where the AVSIN

system will possibly lead U. S. education if it is accepted.

The key element in the AVSIN system is that the program material is developed and produced on an open-market competitive basis. This means that the various audio-visual companies will be competing with each other to prove that their program series is the best possible method to use in teaching any particular educational skill. Teachers, principals, and school boards will be put in a position where they will be paying money for a program which is expected to teach a certain educational skill to a class of students. It is up to the materials producer to prove, through research and testing, that his product is better than his competitor. Widespread adoption of AVSIN will give commercial educators easy access to the educational market through the audiovisual broadcasting medium. Appropriate performance contracts involving AVSIN suppliers and users might be developed to insure adequate performance.

In many areas of this country, education, public and private, is on the verge of bankruptcy and collapse. Teachers are continuosly demanding more money. Parents are demanding better education for their children and for their tax dollar. Communities across the nation are continously turning down educational bond issues which will raise the local tax base. In this time of tight money, many school districts are laying off teachers for the oncoming school year and a "surplus" of teachers has developed. The possibilities of school systems making large financial outlays for technological hardware appear dim. It is time to stop and consider alternative solutions to the traditional education structure. New approaches such as the "Open Classroom" are efforts of this kind.

As long as technological hardware is considered an additive cost, that is, an expenditure made in addition to the normal teacher-classroom cost, technological innovations will be hard to justify. However, if technology can be shown to cost effective by either partially replacing the teacher or by making it possible for him to educate twice as many students in the same amount of time, then arguments for further technological expenditures will gain more support.

Some schools in the future may find it economically and technologically feasible to replace some teachers with less costly paraprofessionals who has empathy for children and who can be trained to coordinate audio-visual media in the classroom. The curriculum would be chosen by the school principal or school board on a performance contract basis. The programs would be administered in the classroom by a trained non-professional who would circulate among the children helping them with their problems and acting as a consultant and supervisor. However, whether or not such developments occur depends upon political and other factors. The proper mix of teachers, paraprofessionals and technology which can help meet the needs of students is a subject worthy of further intensive study and experimentation.

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